Active Region Jets II: Triggering and Evolution of Violent Jets

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Francisco Martinez (summer 2016 REU Student)

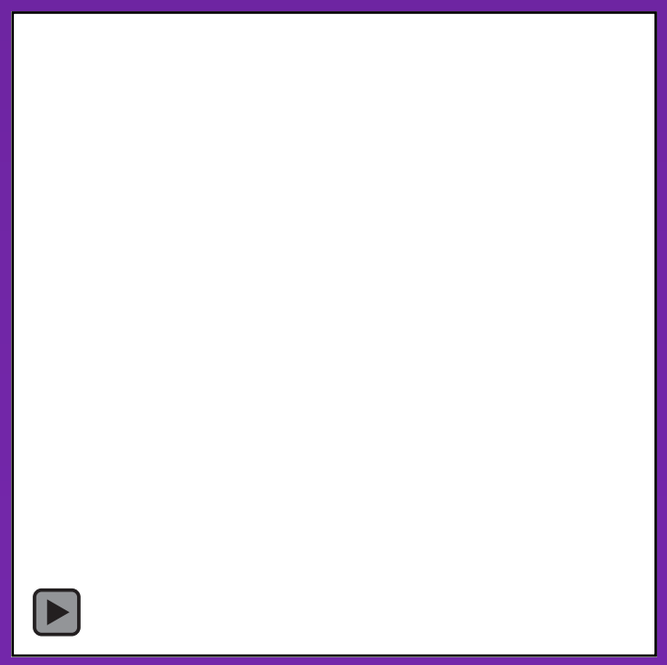
Supported by NASA's LWS and HGI programs, NASA NPP program, and MSFC/Hinode project.)

Introduction

- Coronal jets are well seen in X-rays and in EUV (e.g., Shibata et al. 1992, Shimojo et al. 1994, Cirtain et al. 2007, Nisticò et al. 2009, Raouafi et al. 2016).
- Often have a “jet bright point’’ on one side of the jet’s base.
- Seen in coronal holes, quiet Sun, and active regions.
- AR jets are similar in appearance to non-AR jets; AR jets are longer and more energetic.



Cirtain et al. (2007)



Sterling et al. (2017)

Today's Discussion:

- AR jets are basically the same as non-AR jets; they all fit the "minifilament eruption" magnetic geometry.
- But, one difference is that frequently a cool minifilmament is not apparent in (violent) AR jets.

- Why not?? (Possible answers provided.)

- What causes the minifilament eruptions?

Coronal Hole Jets

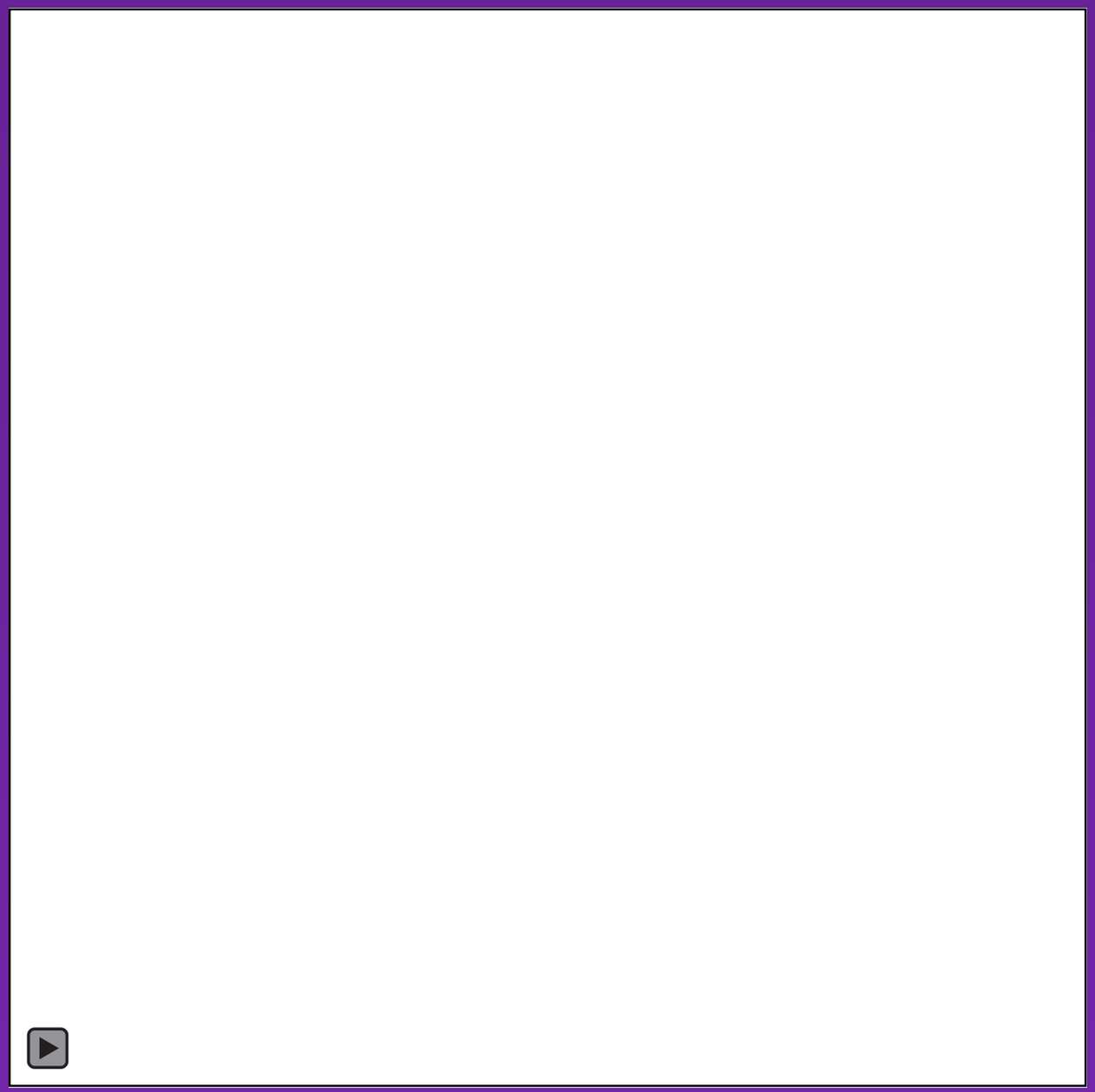
Coronal Hole Jets: “Minifilament eruptions”

XRT

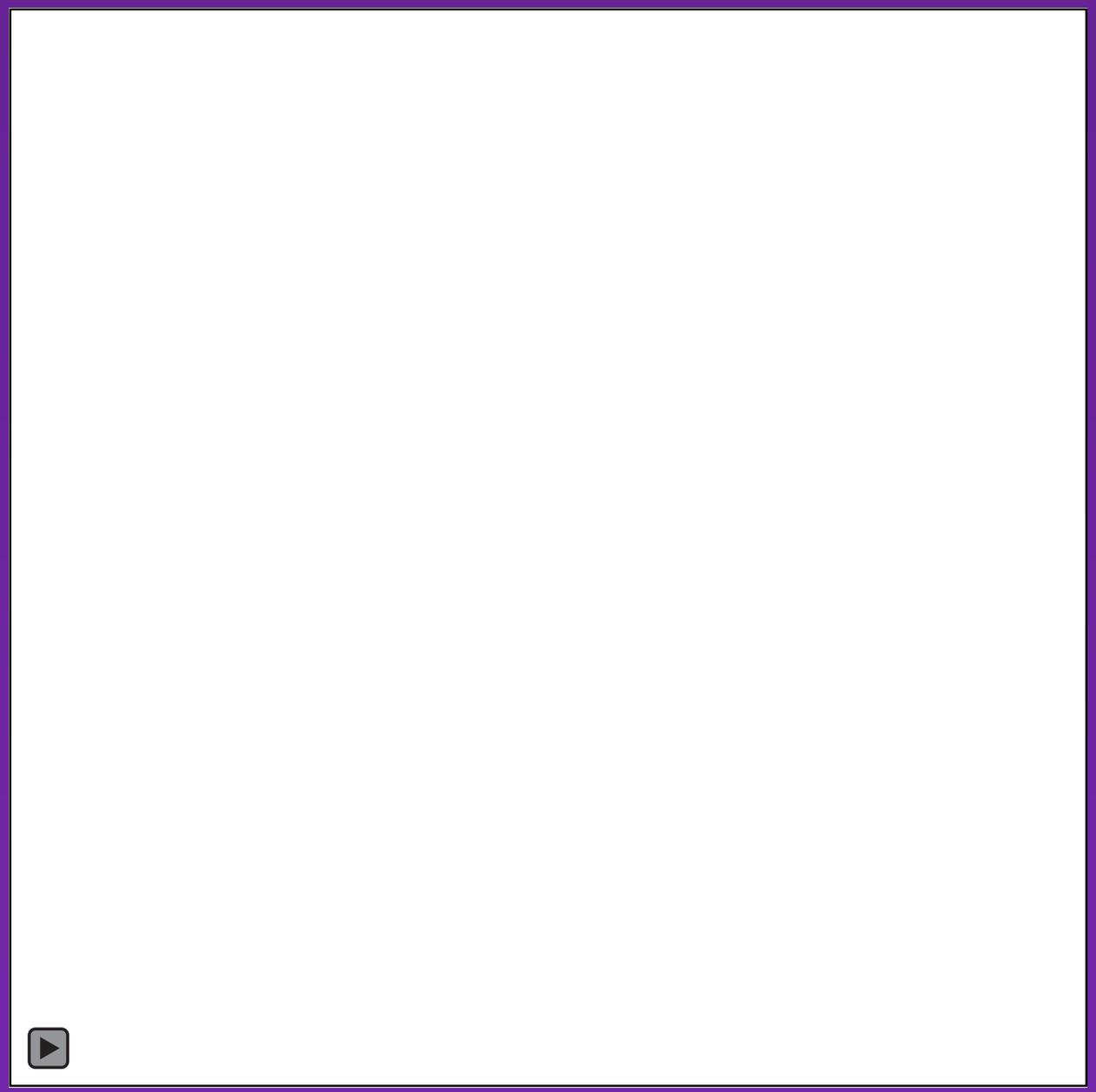
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Sterling et al. (Nature, 2015): 20 Polar CH jets.

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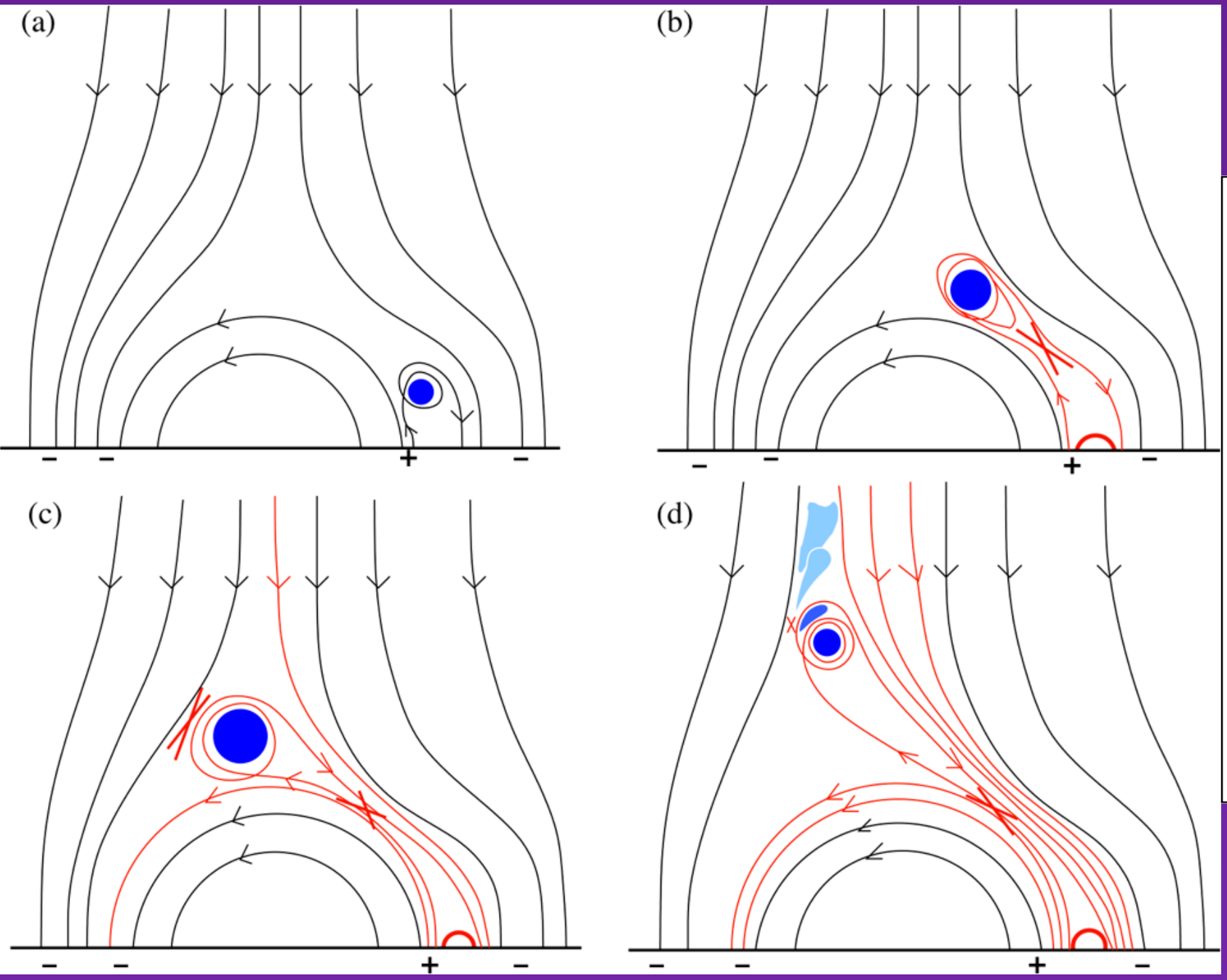


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“Normal” Filament Eruption (TRACE)



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Sterling et al. (2015, 2016, 2017): “minifilament” eruptions.

Quite Sun jets work the same way (Panesar et al. 2016: See talk!)

Recently modeled by Wyper, Antiochos, & Devore (Nature, 2017)

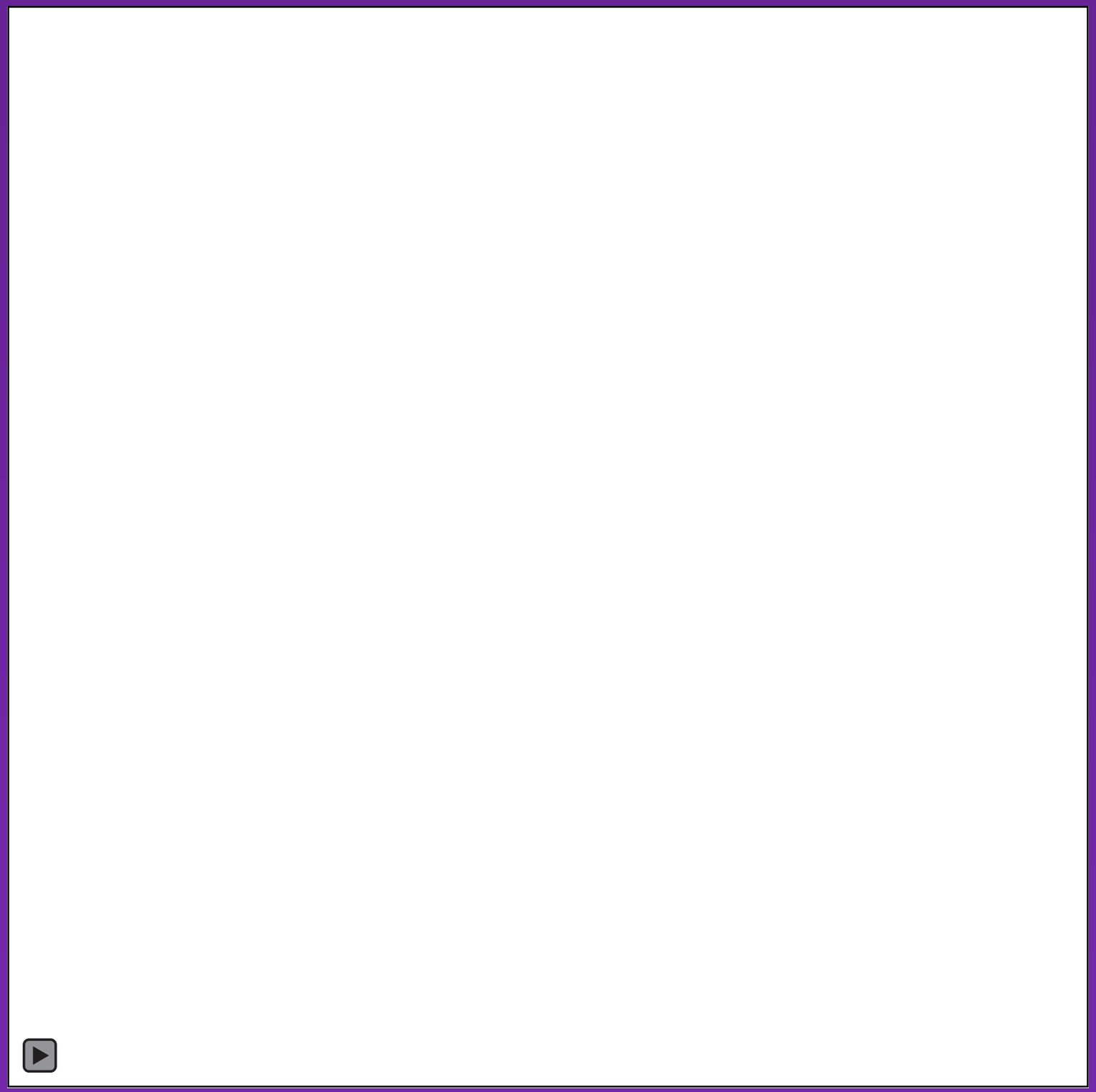
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Active Region Jets

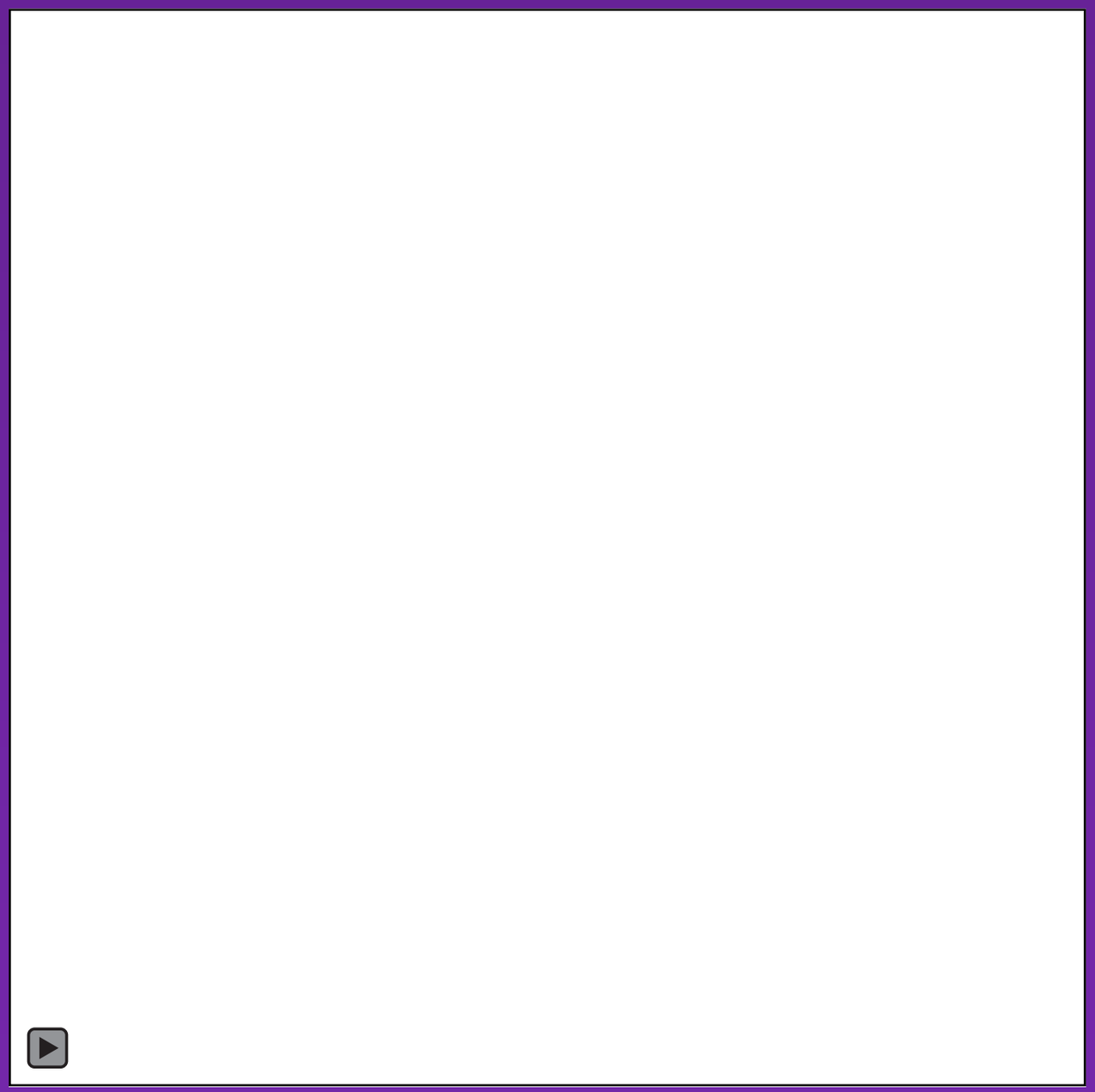
(Sterling et al. 2016)

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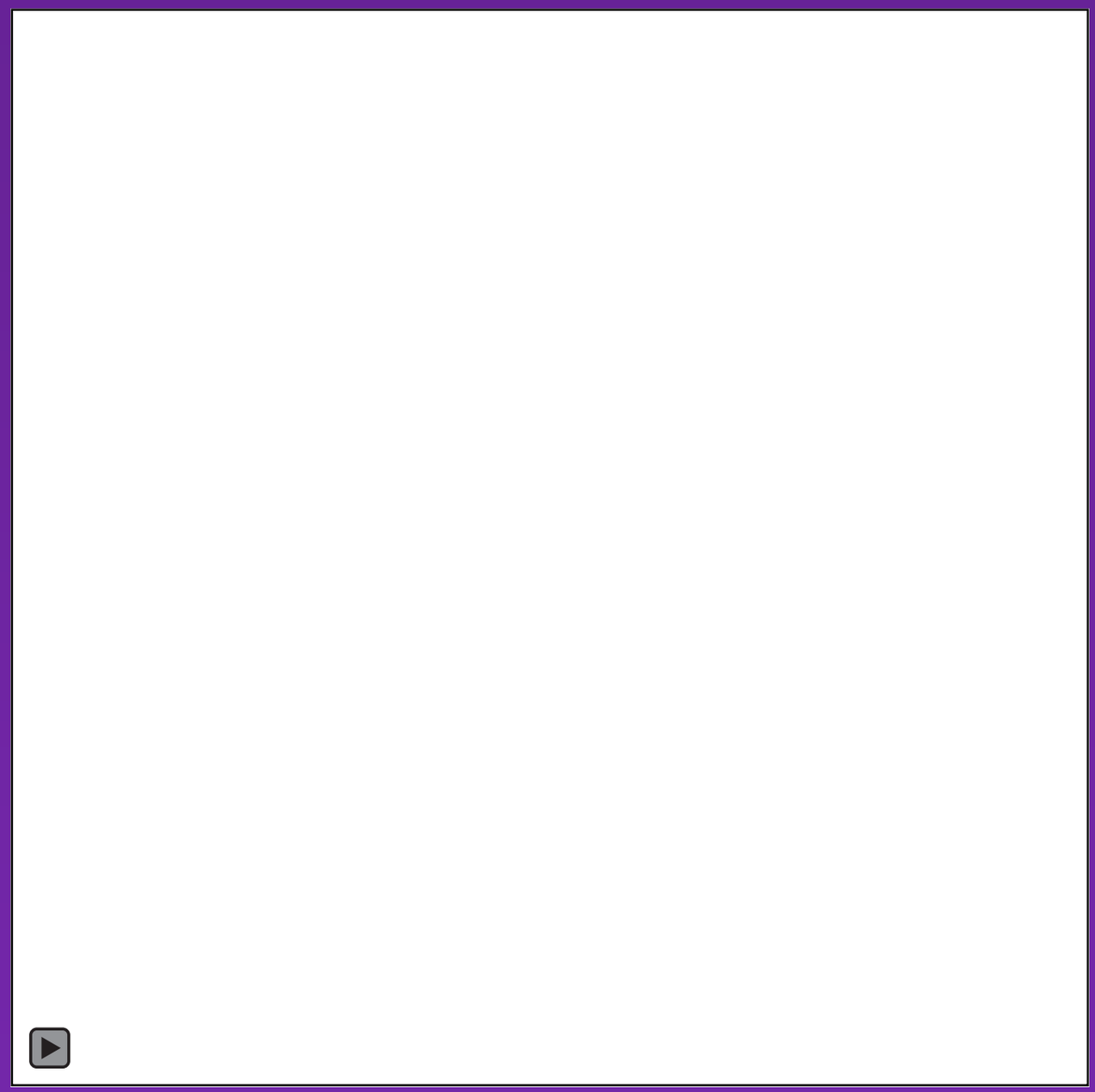
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Sterling et al. (2016, ApJ)



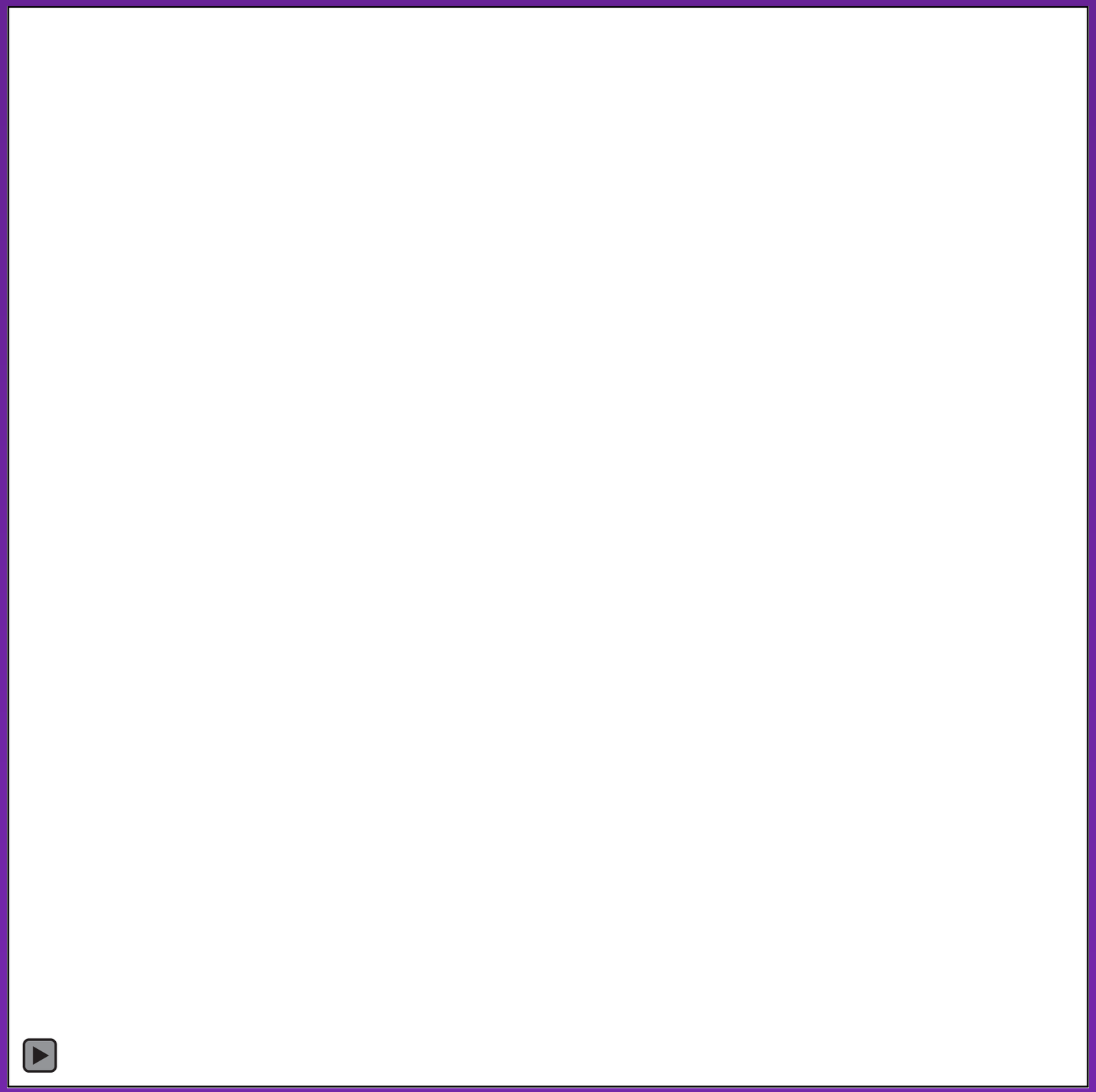
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Sterling et al. (2016, ApJ)

Active Region Jets: Sterling et al. (2016) Results:

- Some AR jets show clear minifilaments; they are slowly developing, less “violent”; surge-like, with weak X-ray signature.

- Other jets show little/no minifilaments; rapidly developing, more violent. Have strong X-ray signature.

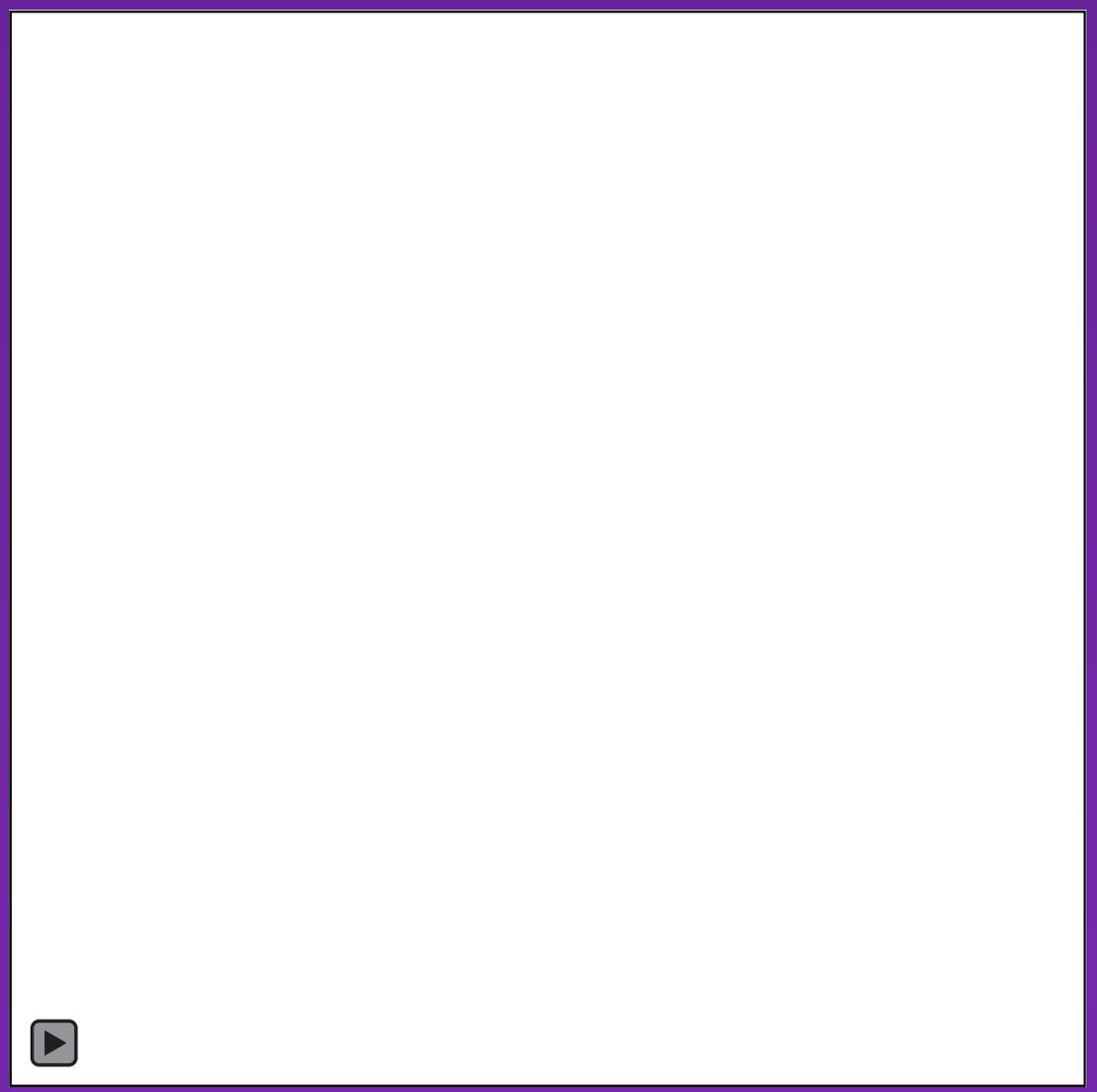
Active Region “Violent” Jets

(Sterling, Moore, Falconer, Panesar, & Martinez 2017, ApJ)

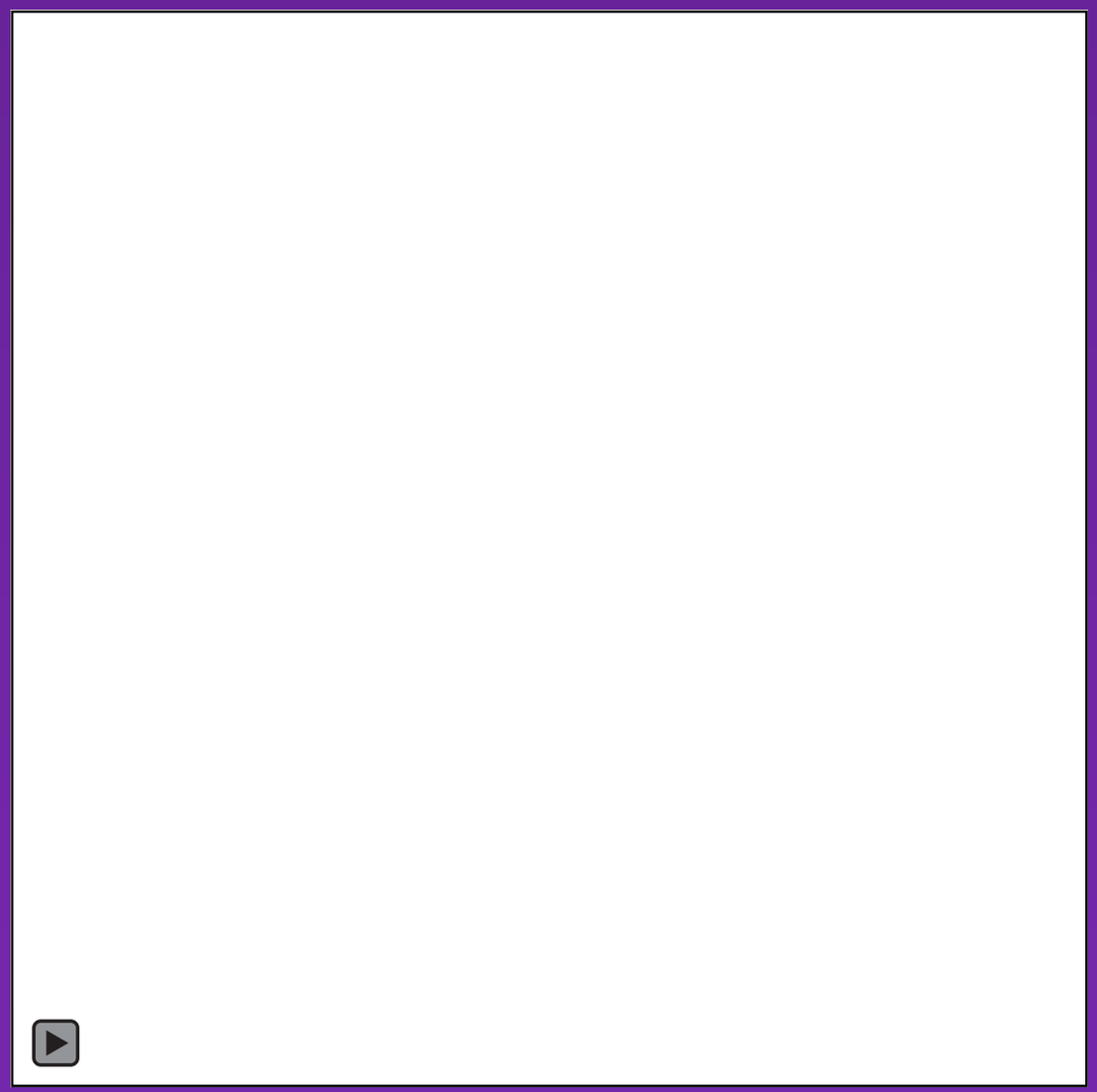
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AR Jet Example 2: To investigate further, look at a different AR — Many violent jets:

- 14 Jan 2015 (NOAA AR 12259).
- AIA, HMI, Hinode, IRIS

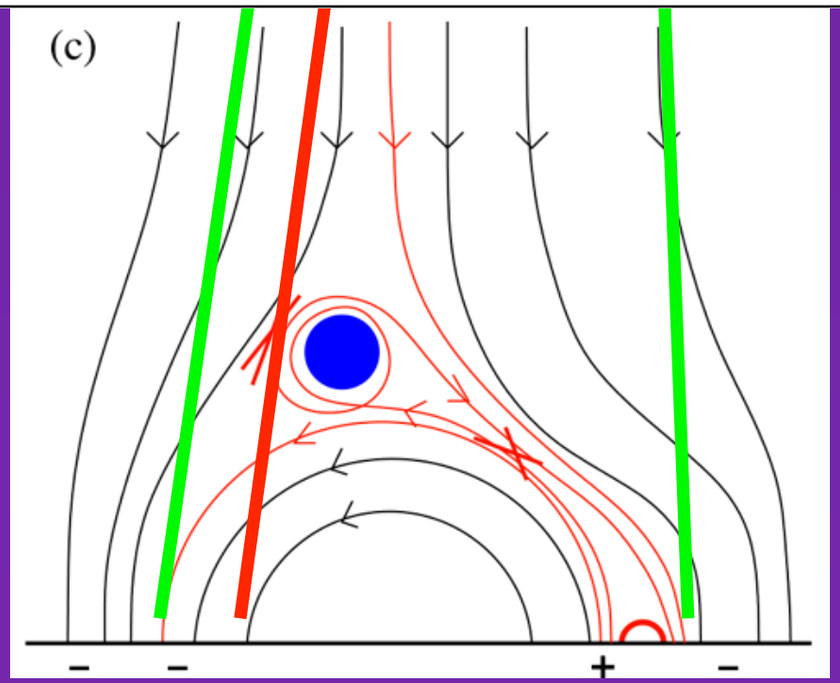


Hinode/XRT



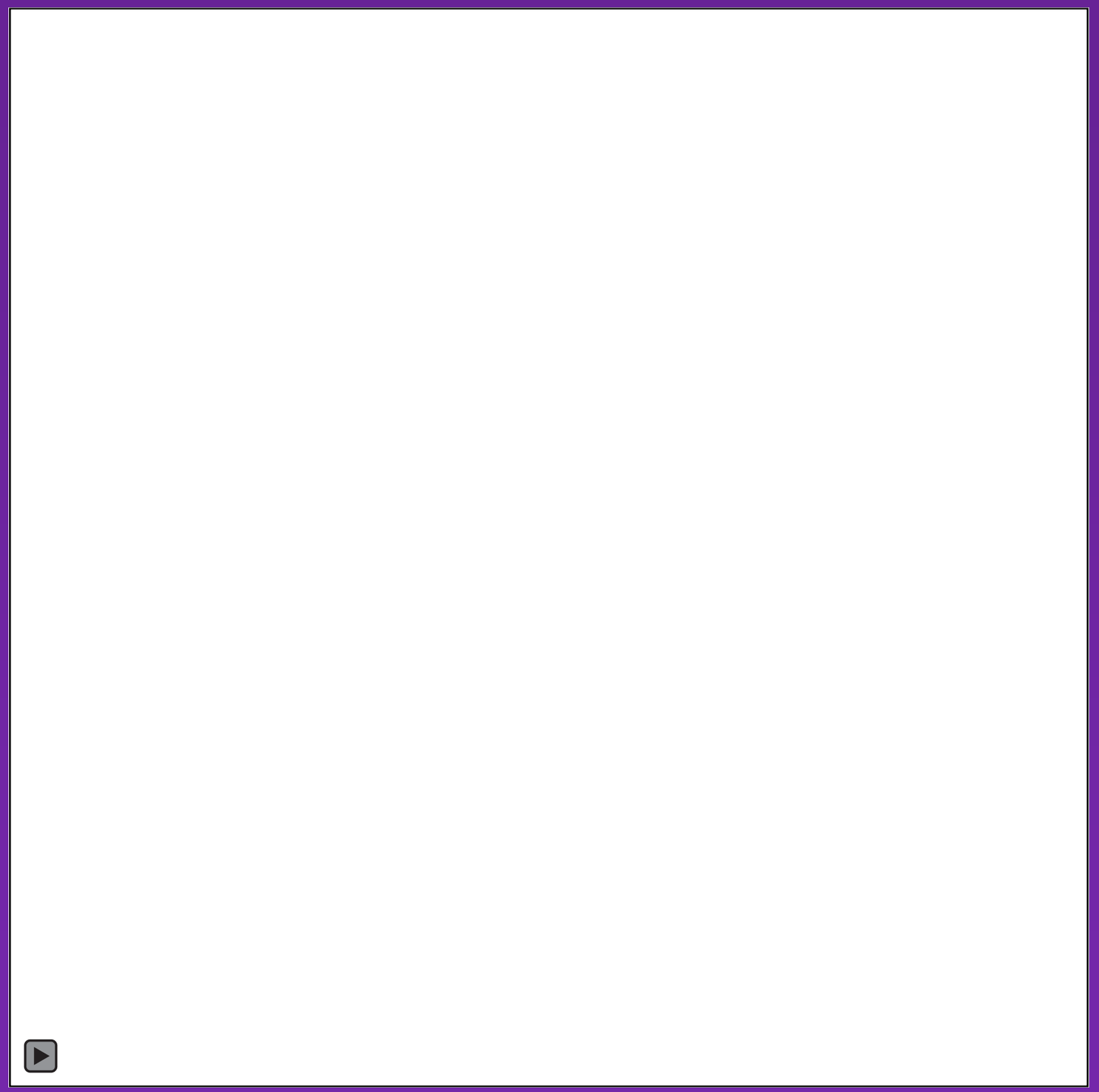
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HMI on IRIS



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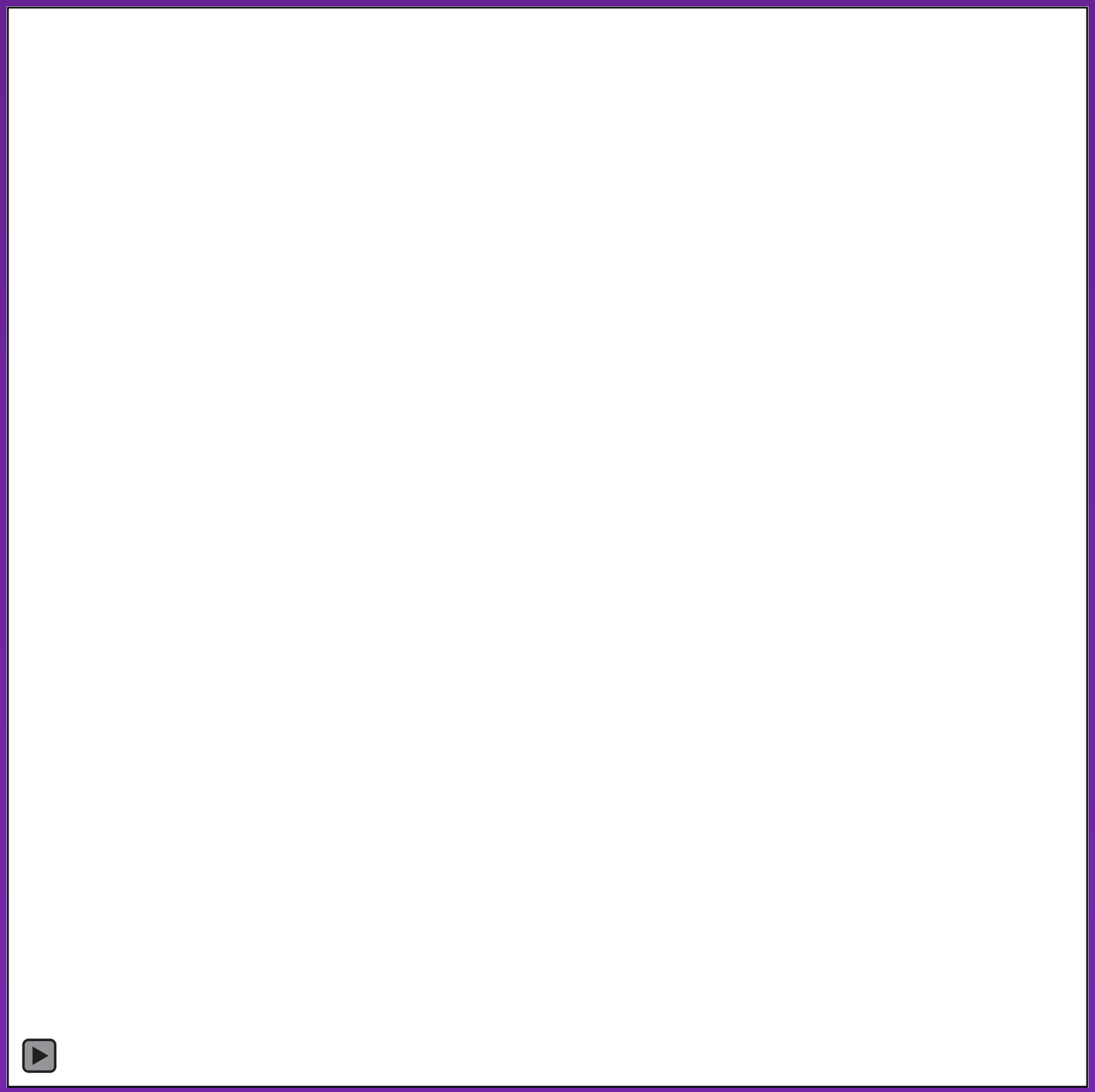
Is cool minifilament material hidden by a bright shell?



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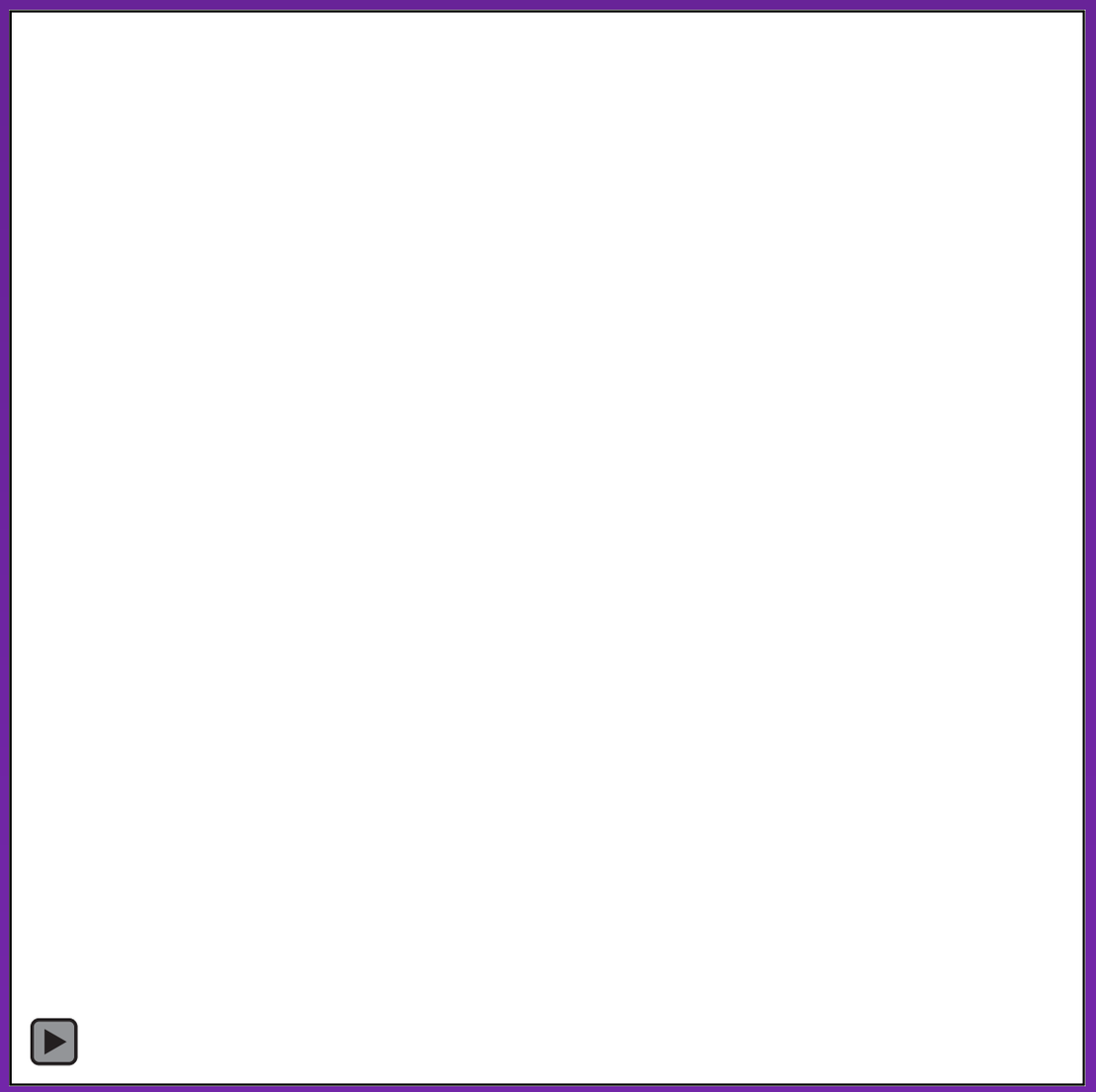
Bright filament “cocoons” envelope
some “normal” large-scale eruptions too:

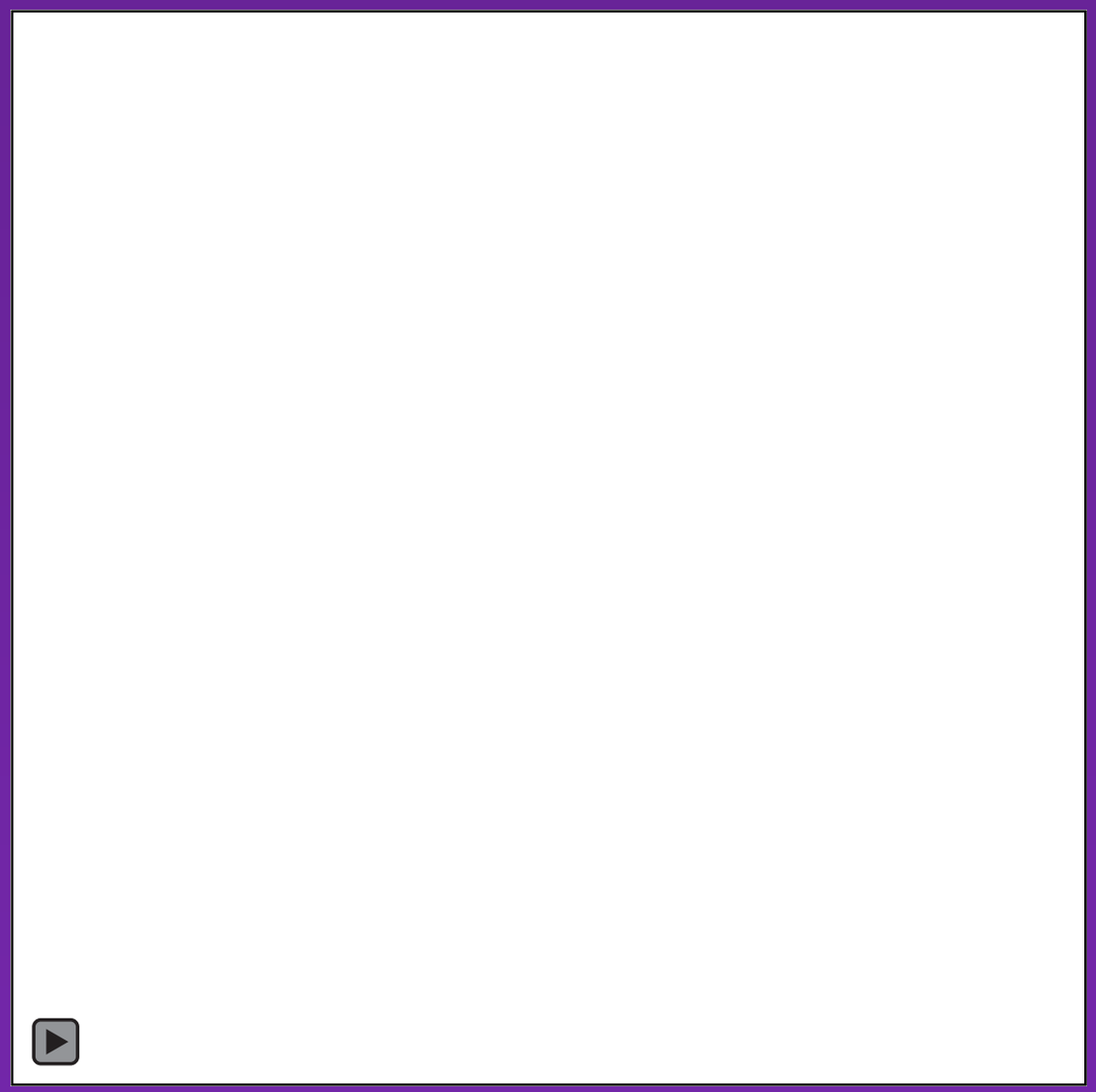


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Consider neighboring jetting location:

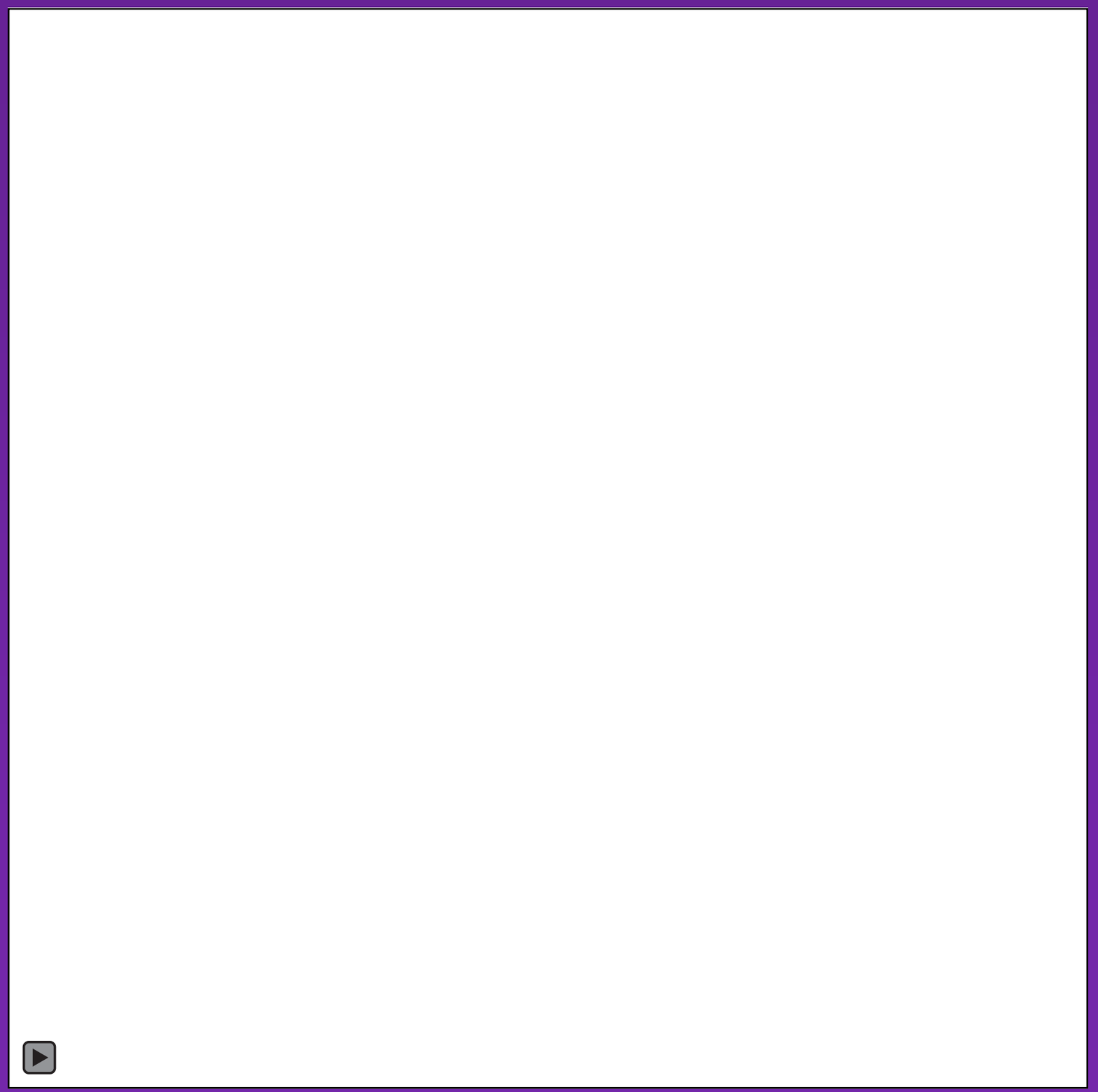




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Minifilament “strand” visible from neighboring region, slightly different time.



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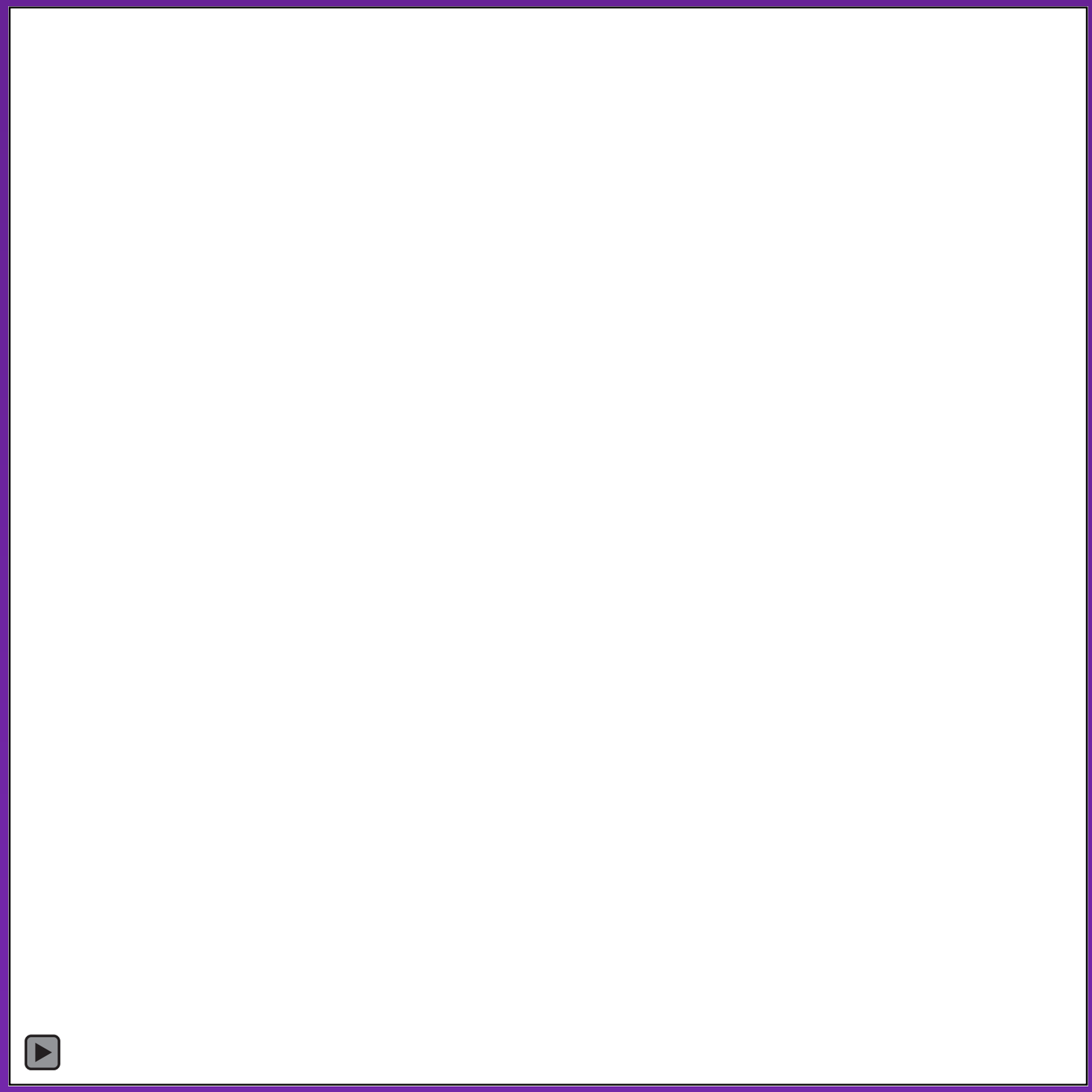
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One More Question (for today):

What triggers jet-producing minifilament eruptions??

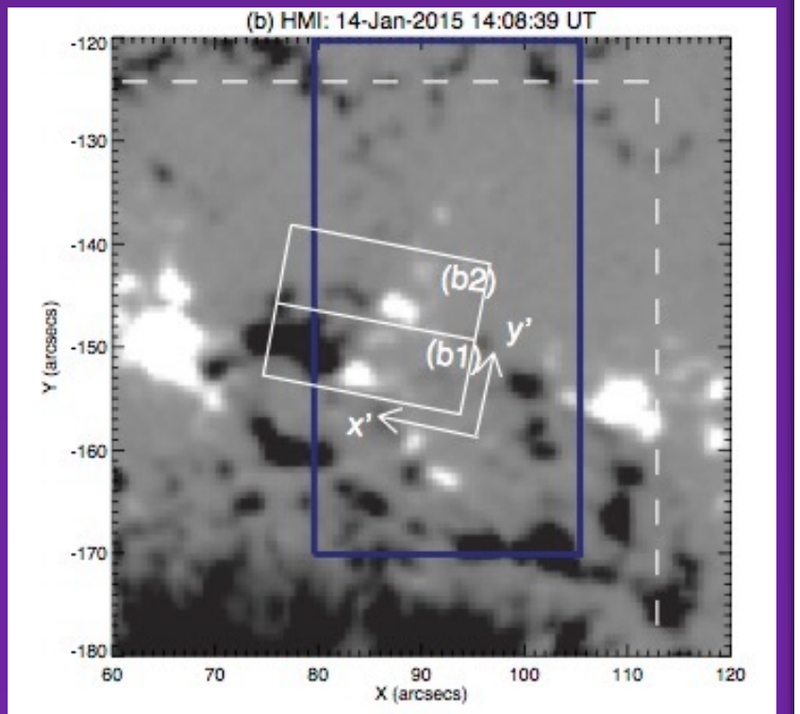
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HMI of IRIS-observed region:

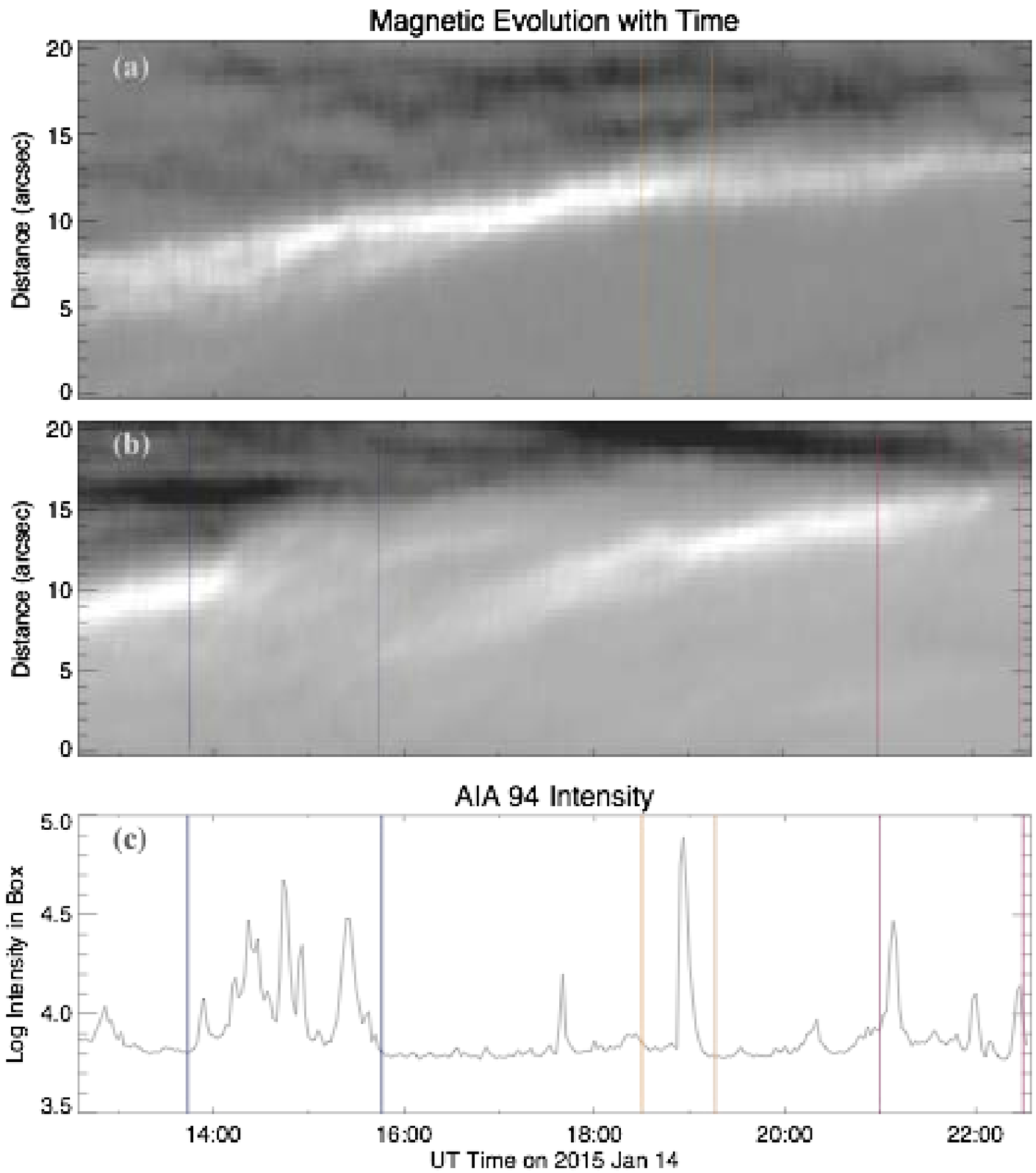


Jets occur at *flux cancelation* locations!

AR jets (Sterling et al. 2017)



Ave. Cancelation rate: ~10^{19} Mx/hr.



Summary and Conclusions

Detailed investigations of several AR jets (~10):

- All occur on neutral lines.
- Visually all fit the minifilament-eruption magnetic-field setup.
- Slower-buildup ones have obvious erupting minifilaments.
- Faster-buildup ones may also have erupting minifilaments, but (1) they may be very thin ``strands,'' and hence hard to see; (2) cool minifilaments may be hidden by emission (cocoon and/or bright jet spire); (3) etc... (Sterling et al. 2017).

- AR jets result from episodes of flux cancelation. (Also QS jets; Panesar et al. 2016, and see talk.)

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Quite Sun Jets

Quiet Sun Jets — Similar to CH jets

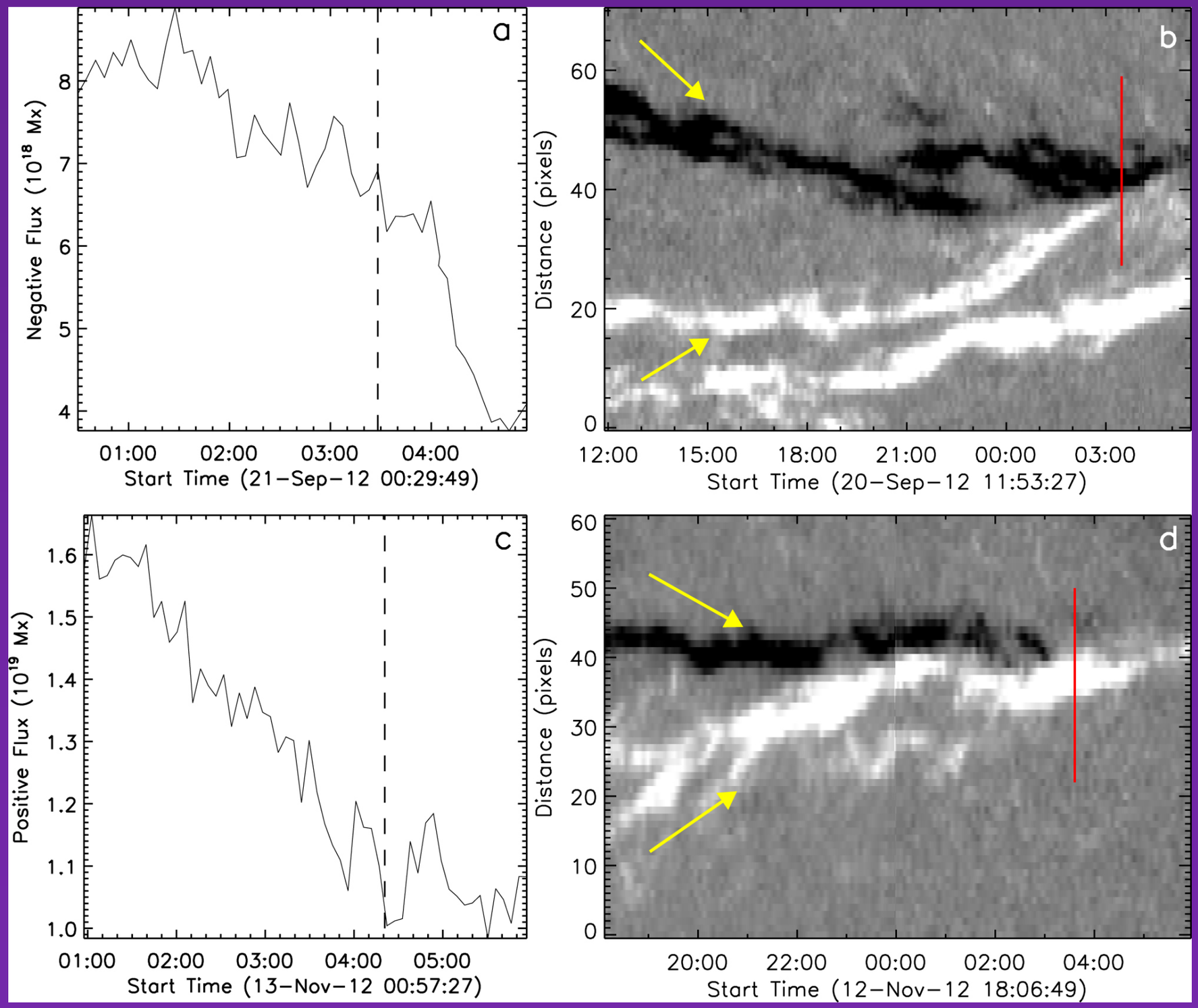
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(Panesar et al. 2016, ApJL; 10 quiet Sun jets: See talk!)

Same for QS jets: Occur at cancelation sites.

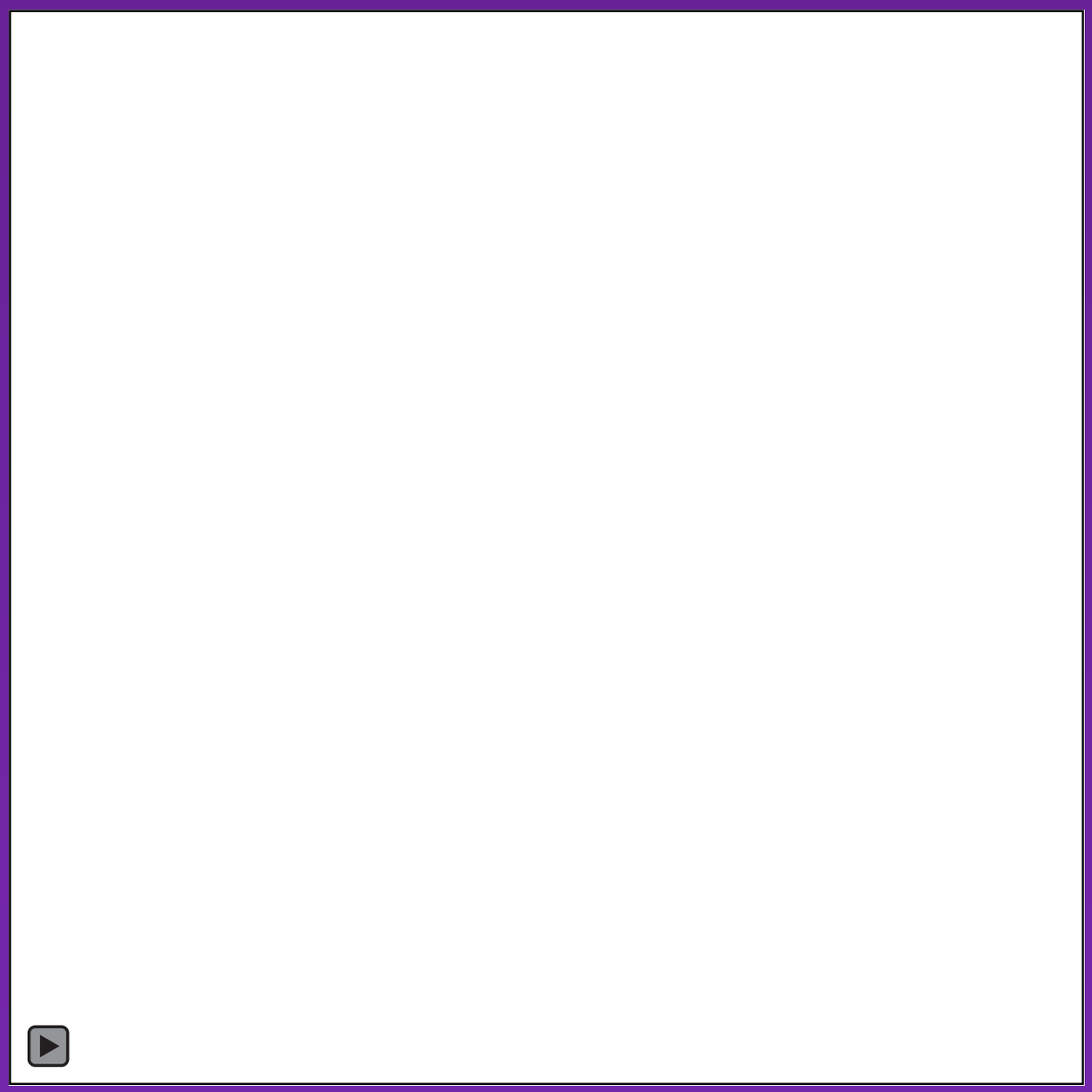
Ave. Cancelation rate: ~10^{18} Mx/hr.



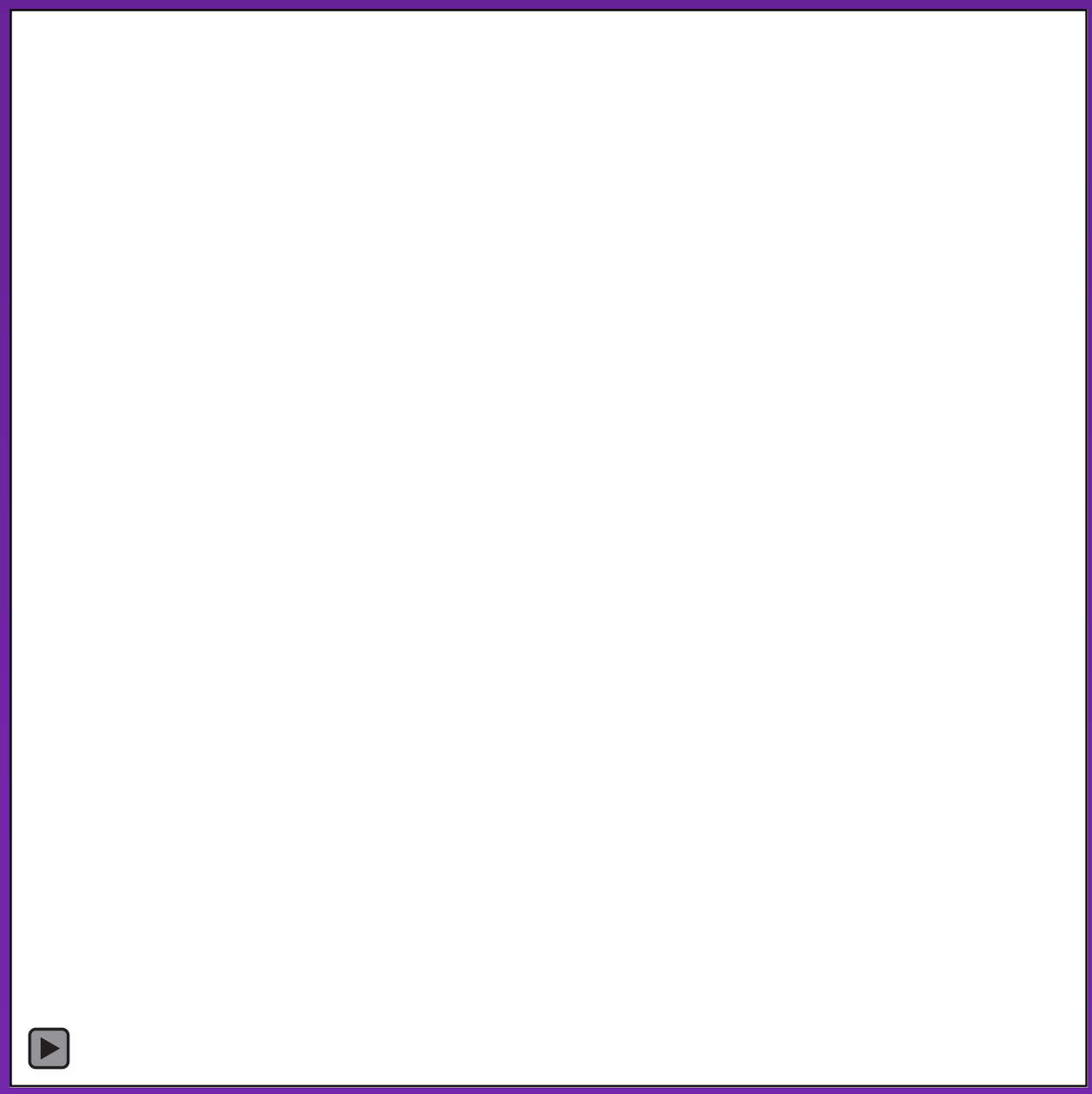
Panesar, Sterling, & Moore (2016) — 10 jets. (Poster!)

Coronal Hole Jets

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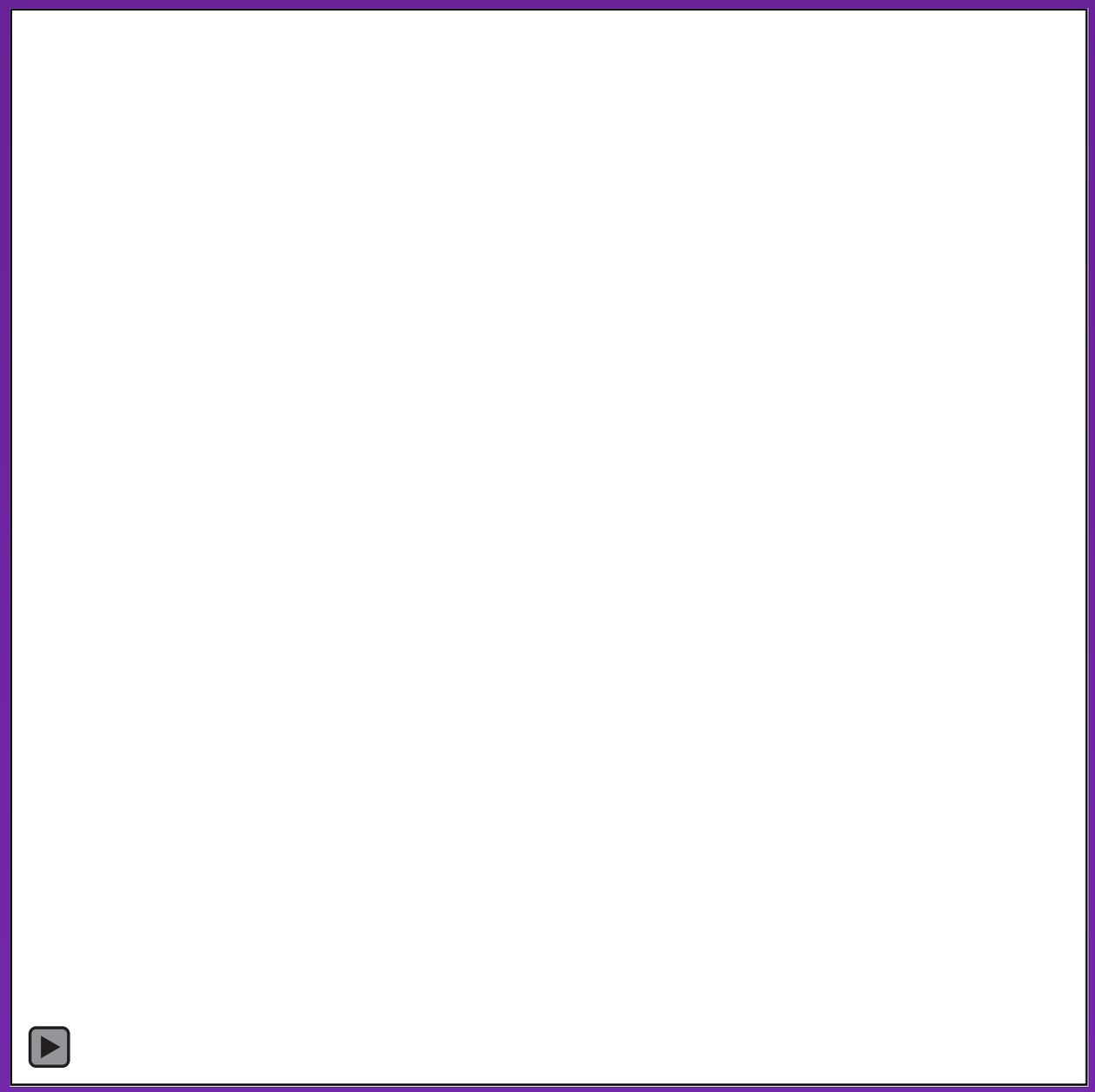
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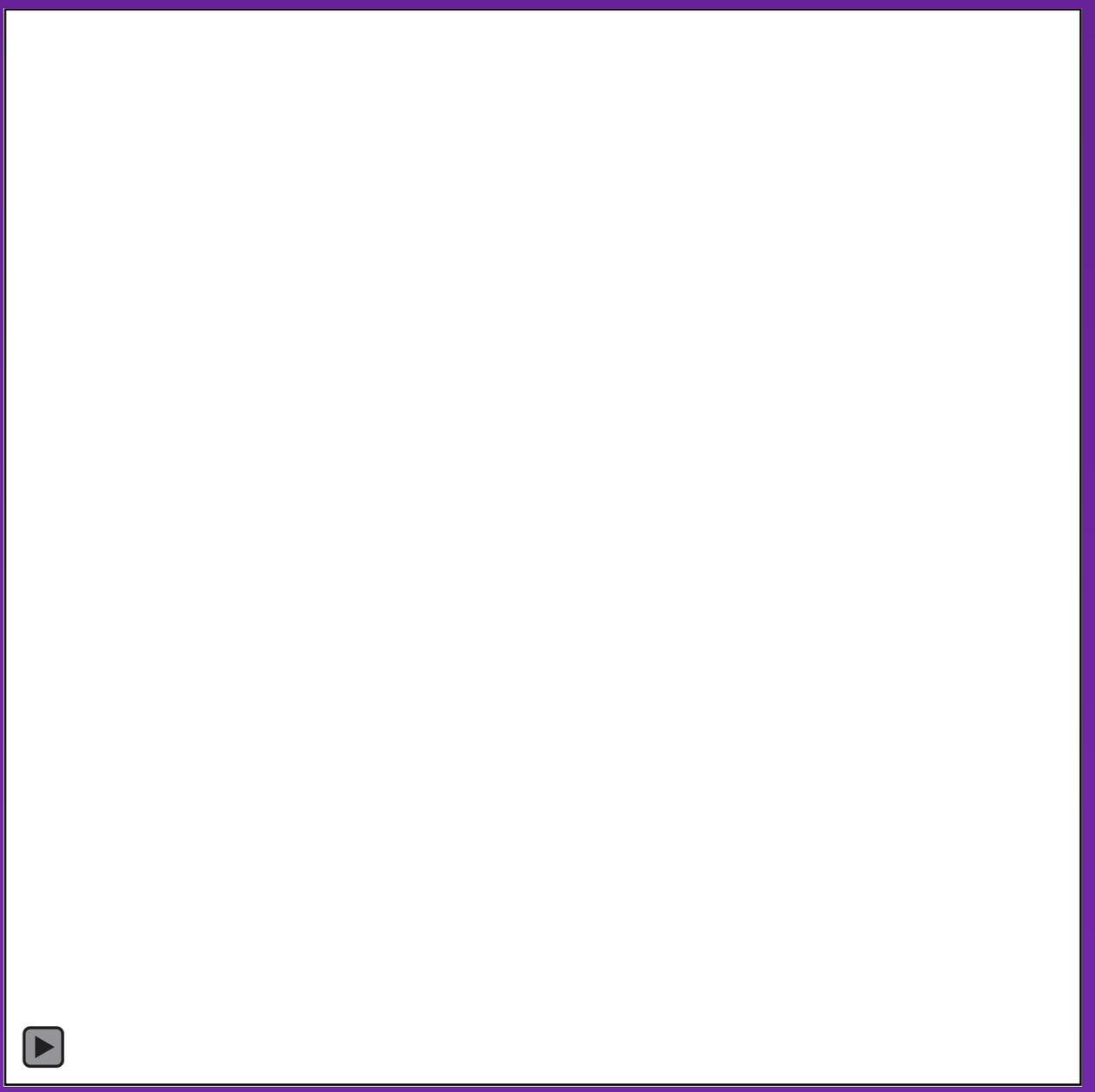


Sterling et al. (2015)

XRT

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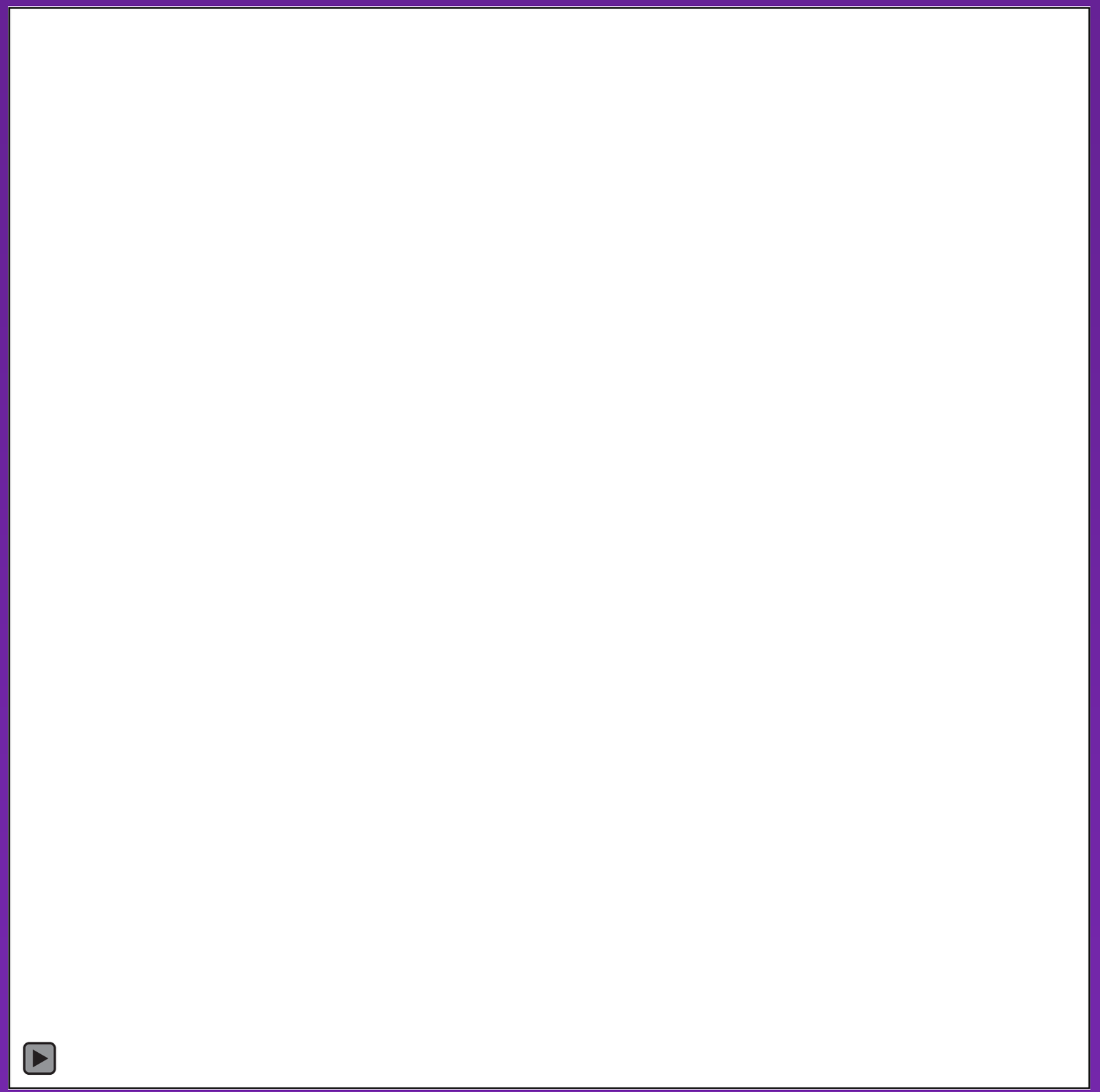




Event 12

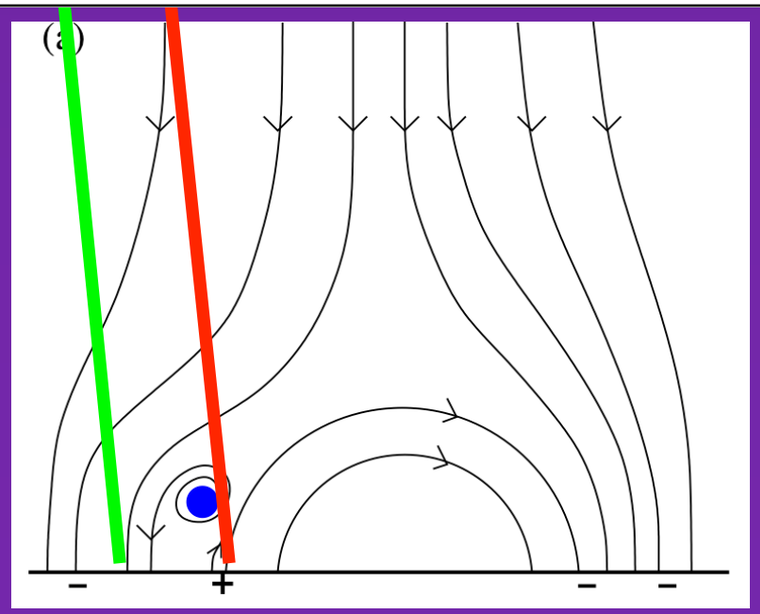
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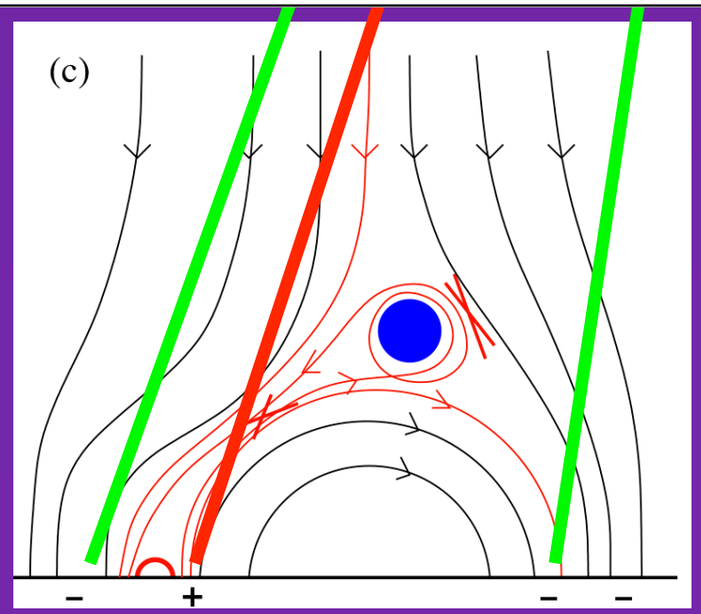
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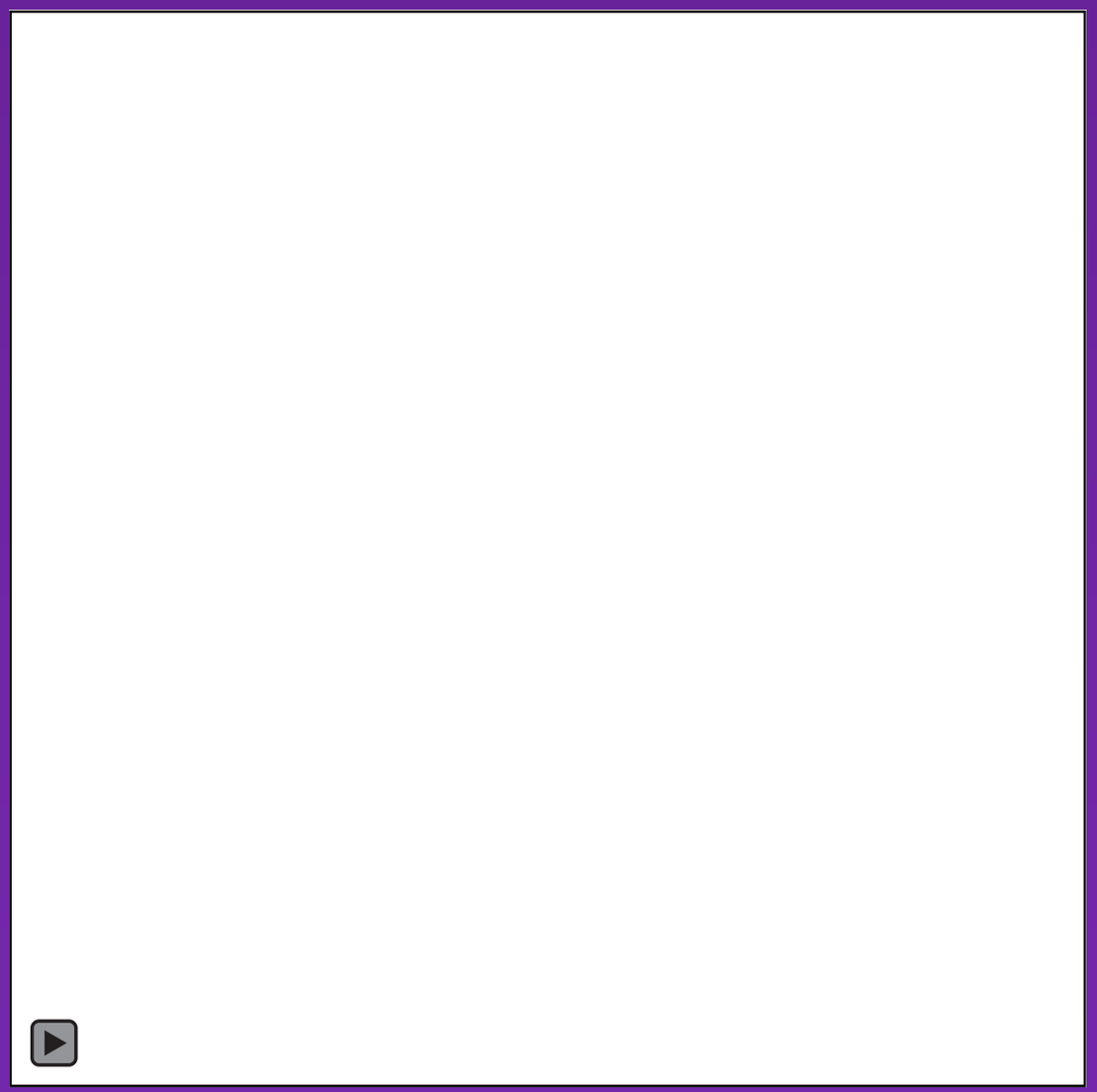


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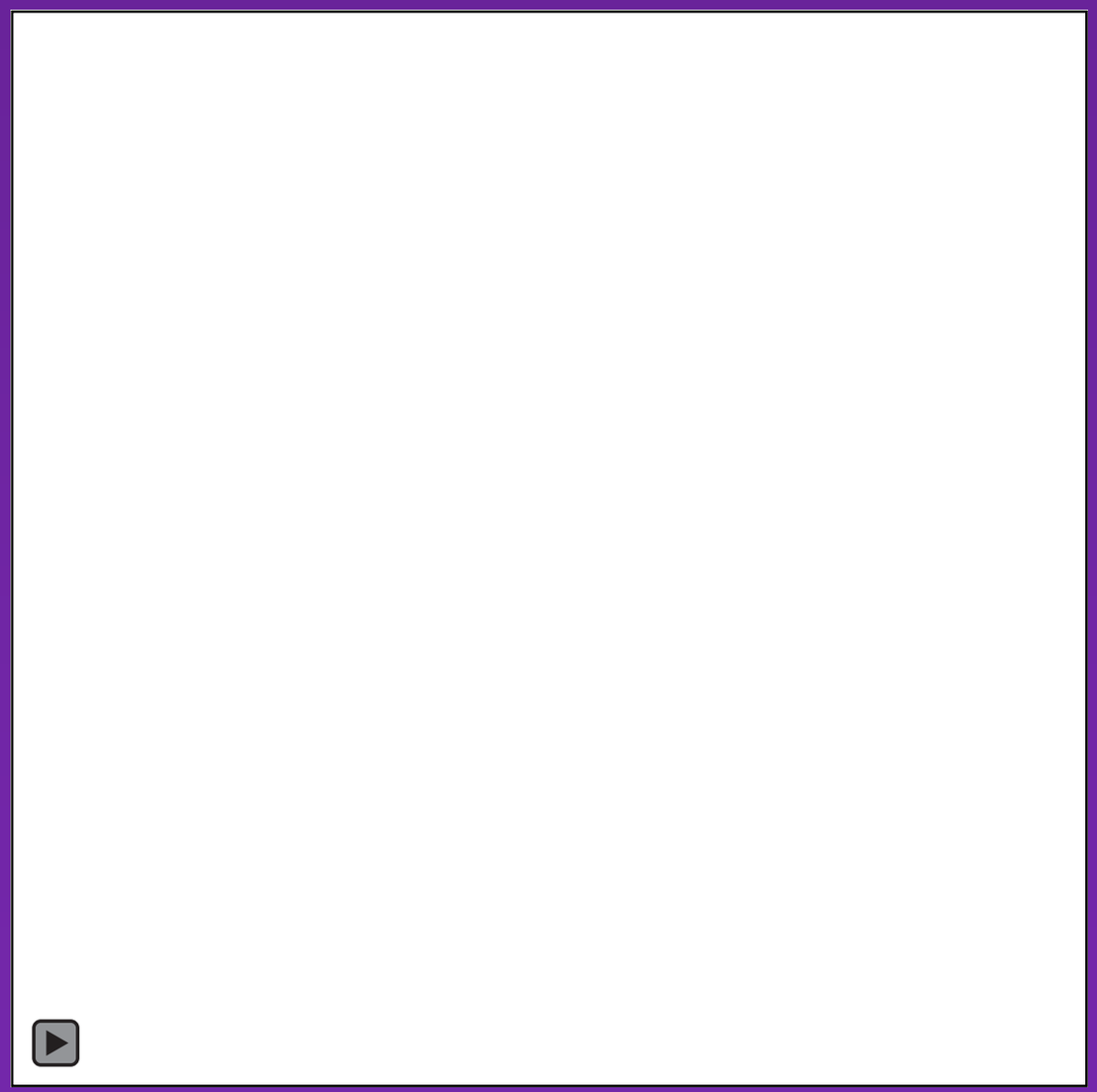
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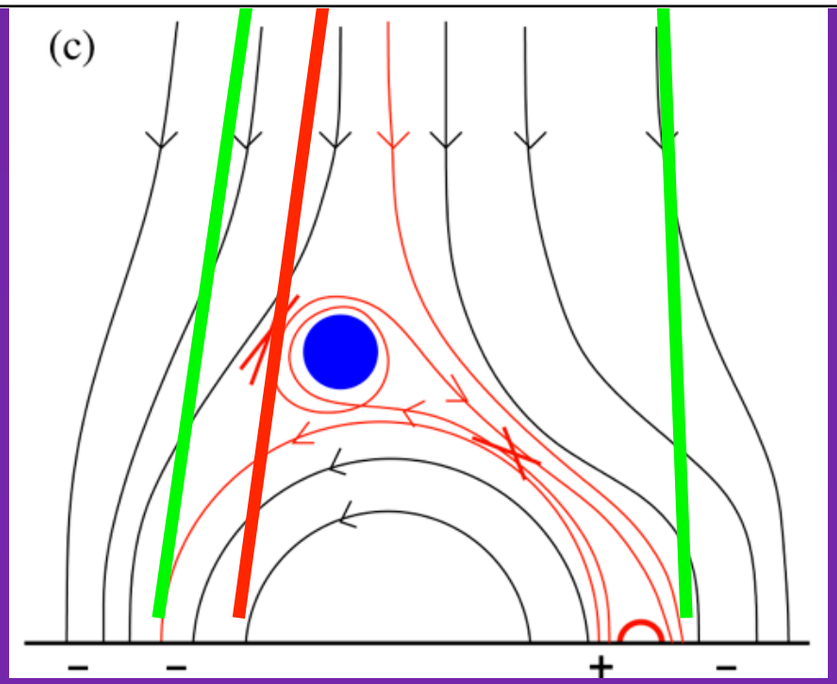
Hinode/XRT



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Flux Cancelation Rates:

- For AR jets (~7 events): ~1.5 x 10^{19} Mx/hr (Sterling et al. 2017).

And from Panesar (2017, private comm.)

- For QS jets (~10 events): (1- 4) x 10^{18} Mx/hr.
- For CH jets (~10 events): (2 - 6) x 10^{18} Mx/hr.

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